Implementation of Emerging Corrosion Control Technologies Program

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The Problem is Bigger Than You Think!

- Corrosion related costs are 14% of the Army M&R budget or $300 million per year... oftentimes neglected. Still no preventive maintenance
- Once failed, systems become mission critical, life-safety, and operational necessity for personnel, families, and equipment
- Focus is on non privatized systems.

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Reason to Worry... Cannot Bury This Issue

- The majority of ACSIM Utility Modernization projects were/are to fix problems resulting from lack of Preventive Maintenance in corrosion related areas.
- Obviously commanders invested in other than utility system related issues... above ground issues. Out of sight... out of mind. DPWs knew problems, but were only patching emergencies.
- Privatization of utility systems does not encompass the focus of this investment. Non-privatized utilities can be included.
- Looking for ways to reduce sustainment costs, provide commercial grade utilities and reliability to customers, and keep the Army environmentally friendly.

Congressional Interest in Corrosion Control

- Senator Akaka (Senate Armed Services Committee, Subcommittee on Readiness and Management Support, DOD Installation and Environmental Programs) had asked Mr. Fiori (Assistant Secretary Installation and Environment):

  "***What initiatives are you taking to reduce corrosion maintenance costs?"***

- ACSIM responded:

  "Army Corrosion Control Program at select installations is to demonstrate and implement emerging corrosion control technologies"

- Mr. Daniel Dunmire (Office of the Secretary of Defense) has been appointed to have oversight and review.

SERO INVESTMENT

	FY02	FY03
DESCRIPTION	$1.420M	$1.984M

Supports SERO Program Management for Corrosion Control for Facilities. Provides funding for SERO-wide implementation of emerging corrosion control opportunities. Products will be implemented systems, including cost and performance data, product specifications, technical assistance, training.

JUSTIFICATION

- Funds implementation of high payback projects
- Utilizes ERDC-CERL to implement innovative technology opportunities to reduce cost and fill technology gap

REASON TO CENTRALLY MANAGE

- Enhances infrastructure management; installations do not have expertise in finding and using emerging technology; saves sustainment funding
- Site visits, quarterly reports to SERO, integrates installation maintenance staff, provides a website (in progress) for Technology Transfer

We Must Do This...

- **FORSCOM Commander's narrative for the FY04-09 POM recommends program CONTINUANCE AND EXPANSION as an Army program.**

- **Potential to include Anti-terrorism/Force Protection in system surveys and projects to include physical security and early warning systems.**

- **Previous implementations have shown large cost avoidances:**
  - **for example, Ft. Jackson**

Leveraged Direct Funding Buildings & Utilities

Army (Mil &CW) Sustaining R&D program: $2 M per Year

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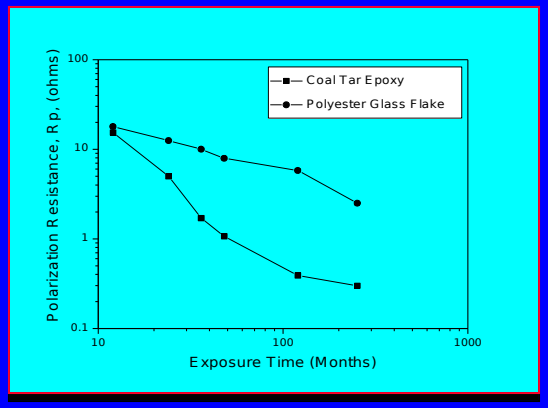
Leveraged R&D for Building Systems and Utilities



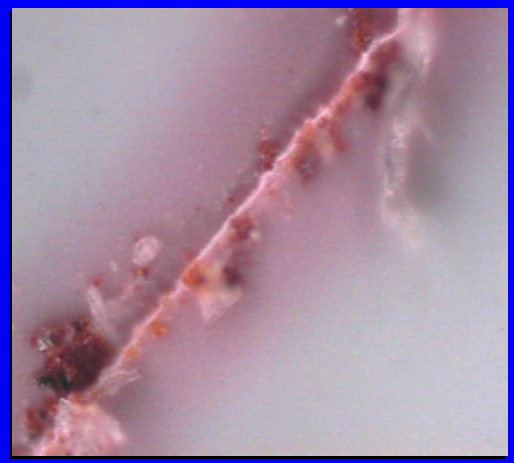
Cathodic Protection:

--Ceramic Anodes

--Remote Monitoring

Materials Selection Guide:

Severely Corrosive Environments



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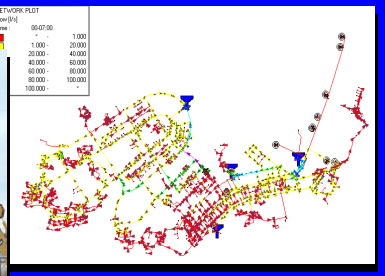
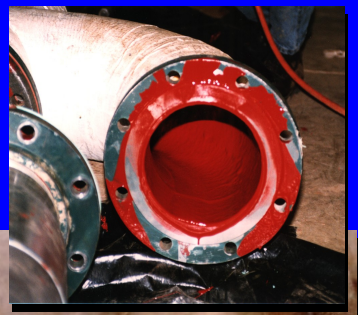
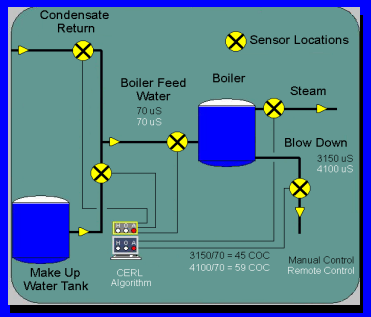
Building Systems and Utilities







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POM Input for the Corrosion Control Technology Program for South East Region (FY03)

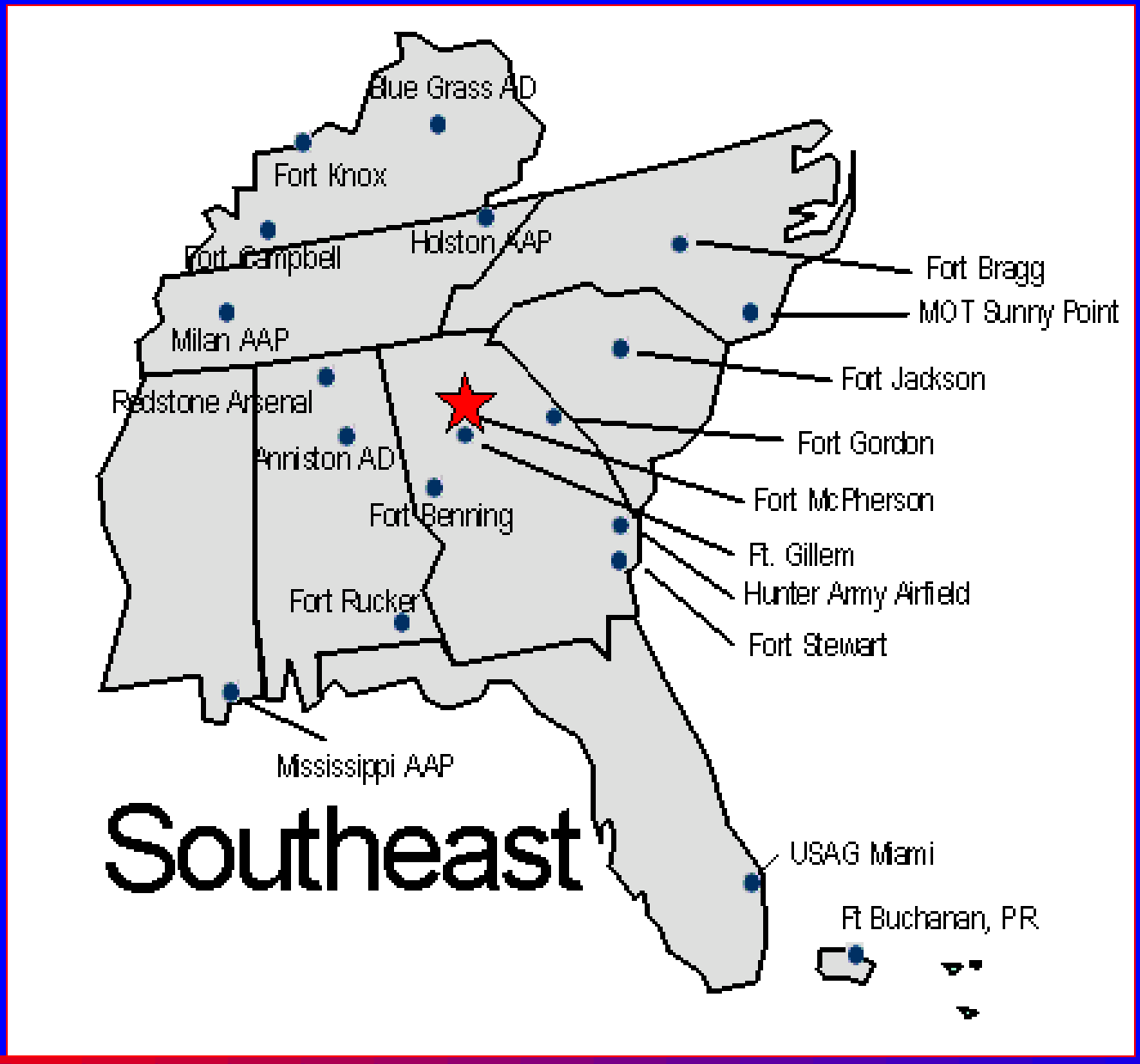
PROJECT NUMBER	PROJECT TITLE	PRIMARY INSTALLATION	FY03
1	Material Selection for Steel Doors and Other Building Components	Ft. Bragg	$170
2	Innovative Coatings for Water Tank (Deluge) & Hangar Doors	Ft. Campbell	$140
3	Remote Corrosion Monitoring & Analysis	Ft. Stewart	$170
4	In-Situ Pipe Coating System for Mitigation of Corrosion (Including Lead and Copper) in Potable Water and Energy System Piping	Ft. Jackson	$75
5	Leak Detection for Water, Fuel, Energy Pipe and Storage Tank Systems	Ft. Campbell	$75
6	Provide Boiler Inspection and Training to All South Region Installations	All SERO Installations	$400
7	Smart Water Treatment for Sustainable SERO Buildings/Installations	Ft. Stewart	$70
8	ElectroOsmotic Pulse Technology for Control of Water Seepage in Concrete Structures	Ft. Bragg	$80
9	Corrosion Control, Materials Durability, and Technology Transfer Workshop	SERO	$60
10	Heat Distribution System Manhole High Water Alarms	Ft. Jackson	$80
11	Heat Distribution Condition/Corrosion Assessment Procedures	Ft. Jackson	$80
12	Assessment and Recommendation of Applicable Corrosion Based Sustainability Improvement Opportunities	Ft. Campbell	$100
13	Remote Corrosion Monitoring of Cathodic Protection Systems for Potable Water Tanks	Redstone Arsenal	$150
14	Corrosion Resistant Materials Selection for Sheetpile	MOTSU, Sunny Point	$180
15	Exterior Coatings for HVAC Water Pipes	Ft. Rucker	$154
	GRAND TOTAL (All $ in Thousands)		**$1,984**

Why Project Order? (Extension of Funds until FY04)

- Most demonstrations are long term and take about 1.5 years for specification development, acquisition and evaluation
- Contracting takes 3 months and funding is already late (April 03)

Implementation of Emerging Corrosion Control Technologies: 15 Projects

- *COATINGS: 3*
- *CATHODIC PROTECTION: 1*
- *ADVANCED MATERIALS SELECTION: 3*
- *WATER TREATMENT: 2*
- *CONTROL OF ENVIRONMENT: 1*
- *CORROSION ASSESSMENT AND MANAGEMENT: 4*
- *TRAINING: 1*



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Innovative Coatings for Deluge Water Tanks and Aircraft Hangars (Ft. Campbell)

Overcoating- Patch tests

- **Problem:** Exterior coating deteriorated on deluge tanks and aircraft hangars
- **Solution:** Moisture cure polyurethane coatings (Sherwin- Williams, Wassar, etc.), can be applied over deteriorated surfaces
- **Benefits:** Service life extension of steel structures,

Advanced Materials Selection (Ft. Bragg)

- **Problem:**

Rusting steel doors

- **Solution:**

-Fiberglass reinforced plastic (FRP)

- **Benefits:**

Extended life, reduced maintenance cost

Old Steel Door

New FRP Door

Example from "Advanced Materials Selection Guide for Severely Corrosive Environments"

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Remote Corrosion Monitoring and Analysis (Ft. Stewart)

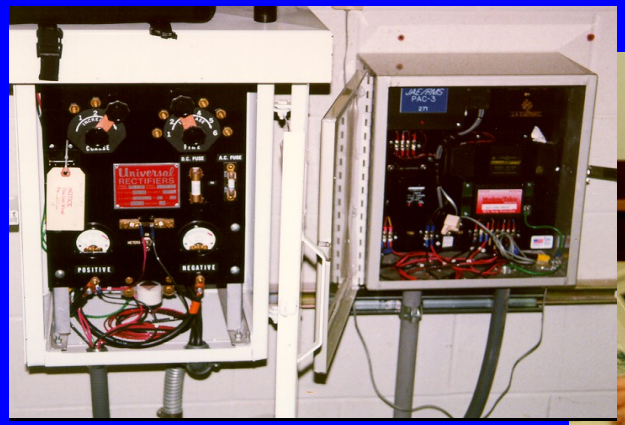
Problem: Corrosion status of underground utilities and above-ground structures needs to be determined

Damaged underground utilities need to located and repaired.

- **Solution:** Implement corrosion condition assessment technologies, e.g., electrochemical impedance spectroscopy (EIS), electrochemical polarization resistance monitoring. Implement innovative utility location systems- robotic crawlers, electromagnetic systems

- **Benefits:** Reduces the need for personnel to travel to numerous field sites to take corrosion measurements.

Remote Monitoring Technology for Cathodic protection Systems and Materials Selection (Redstone Arsenal)



- **Problem:** Cathodic protection systems for water storage tanks must be periodically tested
- **Solution:** Implement remote monitoring units (RMUs)
- **Benefits:** RMU's provide ability to monitor CP system performance data from remote locations

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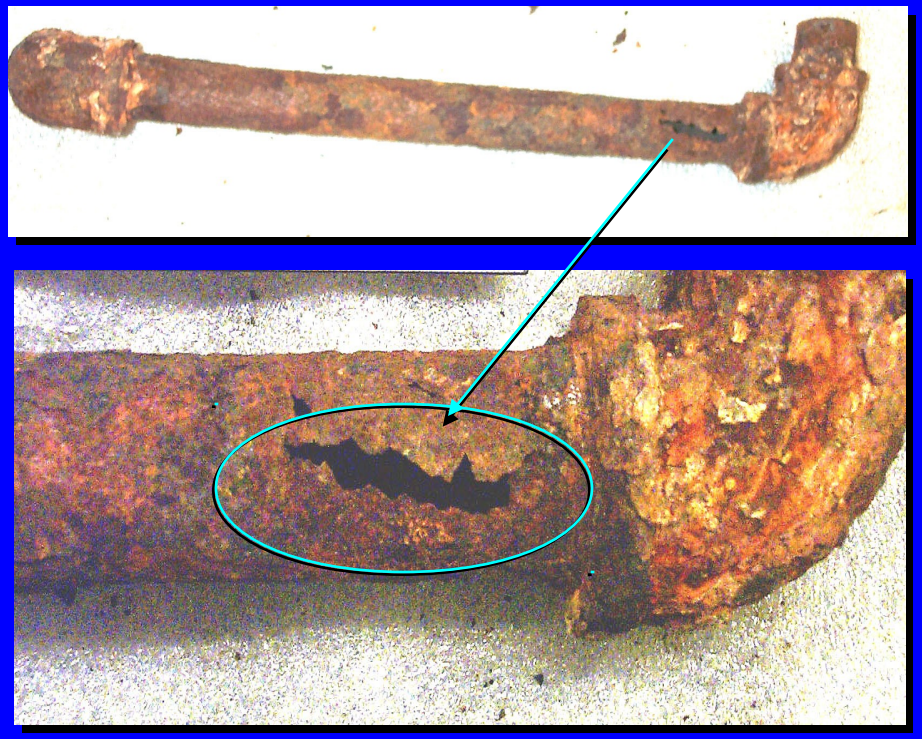
Corrosion Resistant Materials Selection (MOTSU)

- Problem: Structures are susceptible to corrosion in coastal environment
- Solutions: Advanced Coatings and Corrosion resistant Materials
- Benefits: Increase readiness and savings in life cycle costs

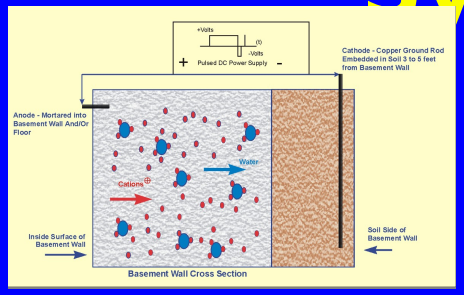
Exterior Coatings for HVAC Water Pipes (Ft. Rucker)

- **Problem:** HVAC black iron pipes corroding inside buildings
  - -burst due to reduced wall thickness caused by corrosion
  - -Insulation becomes wet, because jacketing /weather barrier permitted ingress of water
- **Solution:** Selection of alternative insulation materials and coating materials
- **Benefits:** Enhanced protection of HVAC water pipes, extension of service life, reduced maintenance costs



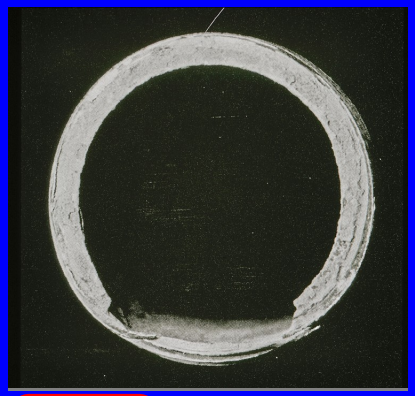
- Specifications for proper coatings, sealing materials, and proper insulation will be developed.

Leveraged R&D for Building Systems and Utilities

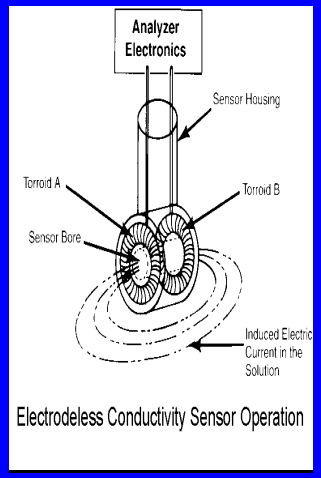

+Volts
-Volts
Pulsed DC Power Supply
Cathode - Copper Ground Rod Embedded in Soil 3 to 6 feet from Basement Wall
Anode - Mortared into Basement Wall And/Or Floor
Water
Cations
Inside Surface of Basement Wall
Soil Side of Basement Wall
Basement Wall Cross Section

ElectroOsmotic Pulse Technology

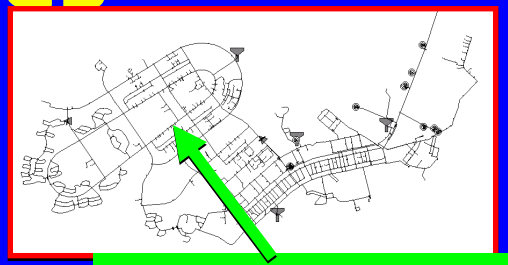
Microencapsulated phase change materials for Heating and Cooling Systems



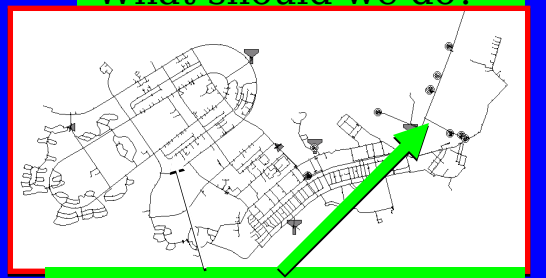
Green Chemical Treatment (ESA)



Smart Water Treatment



Contamination has been detected here. What should we do?



Can the system at the airfield support the extra demand we are expecting?

Dynamic Models for Risk Simulation of Pressurized Utility Systems

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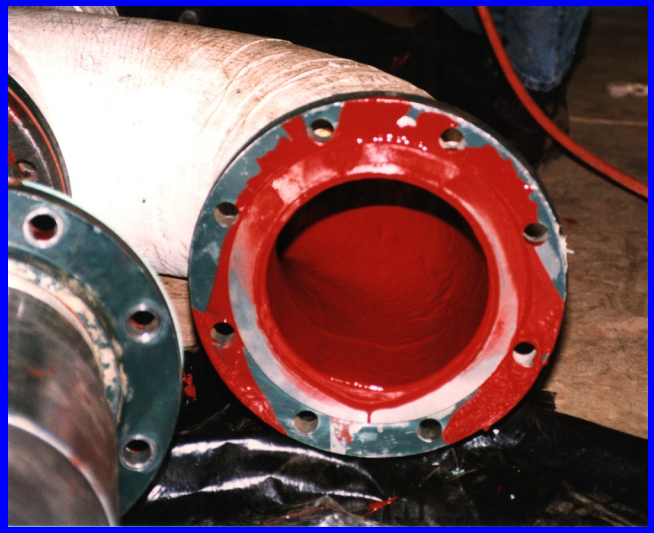
In-Situ Pipe Coating System (Ft. Jackson)

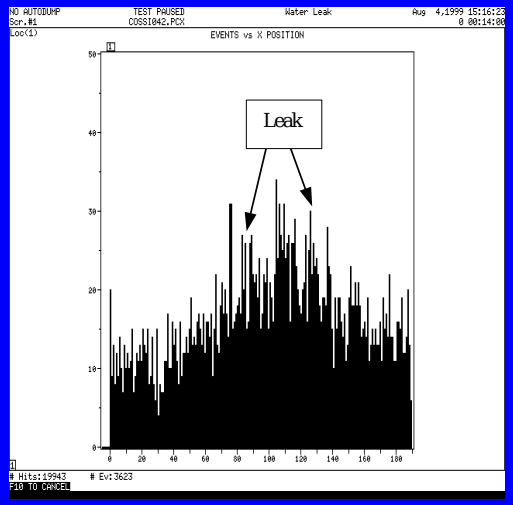
- **Problem**:
  - Lead, copper in drinking water limited by the EPA
  - Scaling, corrosion reduce service life of piping systems



- **Solution**: In-situ coating application can eliminate corrosion/scaling in heating, cooling, and potable water distribution systems and leaching of metals into plumbing systems

- **Benefit**:
  - Compliance with drinking water standards
  - 30% cost reduction vs. replumbing
  - Eliminates corrosion and scaling

Leak Detection in Water, Fuel, Heating, and Cooling Distribution Systems (Ft. Campbell)



- **Problem**:
  - Army maintains 3K miles of heating and cooling distribution pipes
  - Conventional leak detection and location costs $15K to $50K per leak

- **Solution**: Acoustic emission detect leaks as low as 0.1 gallons/hour and locate them within 5 ft.

- **Benefit**:
  - Reduces cost of leak detection and location
  - Reduced leakage

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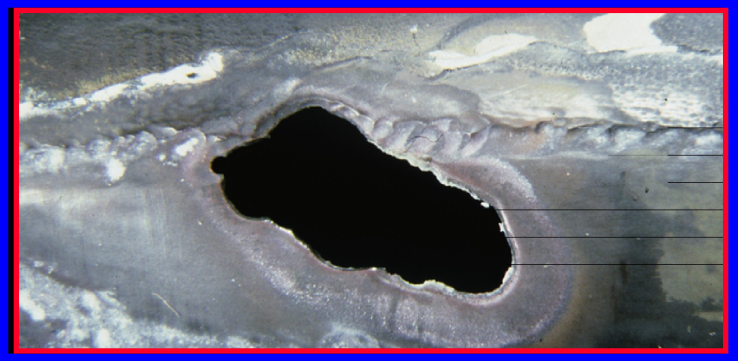
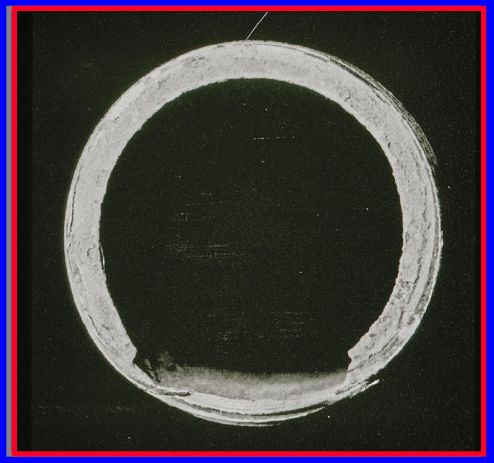
Boiler Inspection and Training (All 20 SERO Installations)

- **Problem: Poor inspection results in reduced boiler system reliability, safety, and efficiency.**
- **Solution: Provide periodic on-site inspection of boiler plants and training for plant operators.**
- **Benefits: Increased boiler system safety, service life, efficiency, and reliability.**



Boiler Tube – Oxygen Pitting Failure Fire Tube Boiler

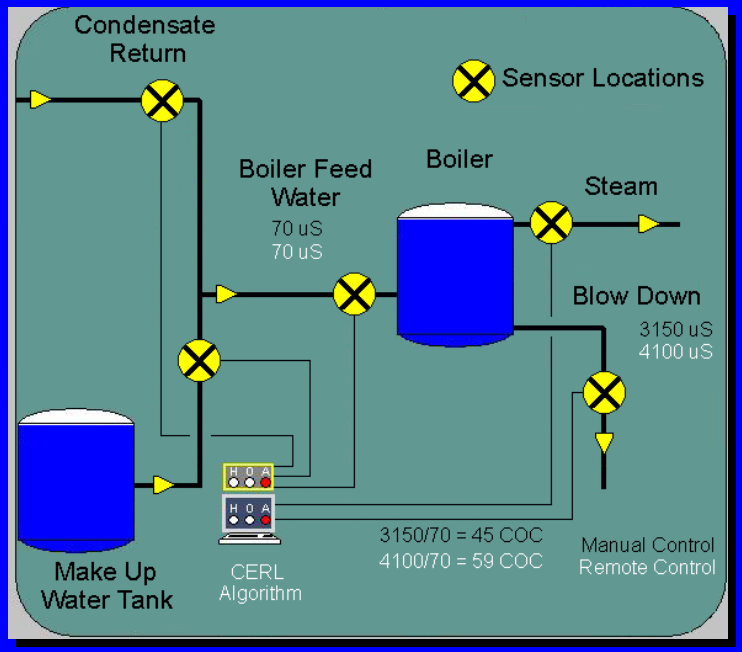
Water Tube Boiler Pitting Failure



Condensate Return Pipe Gr
Caused by Dissolved CO_2 At

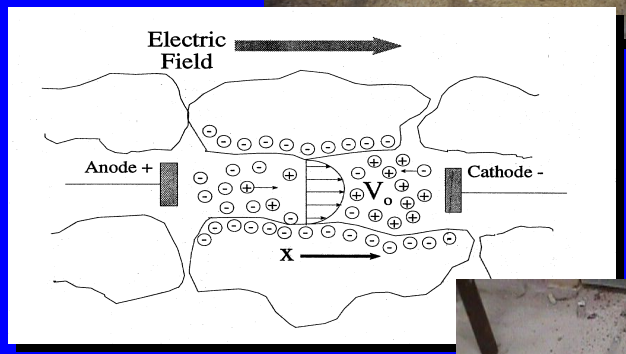
Smart Water Treatment for Sustainable SERO Buildings/Installations (Ft. Stewart)

- **Problem**:
  - Army condensate lines are subject to severe corrosion
  - Neutralizing amines are not used in steam systems for humidification and cooking
- **Solution**: Alternative green chemicals such as ethoxalated soya amines offer low toxicity
- **Benefit**:
  - Green chemistry alternatives are being used for control of corrosion in steam condensate systems, closed loop heating systems, and open and closed loop cooling systems for purposes Reduced cost of condensate replacement due to corrosion



Automated Boiler Water Treatment Loop

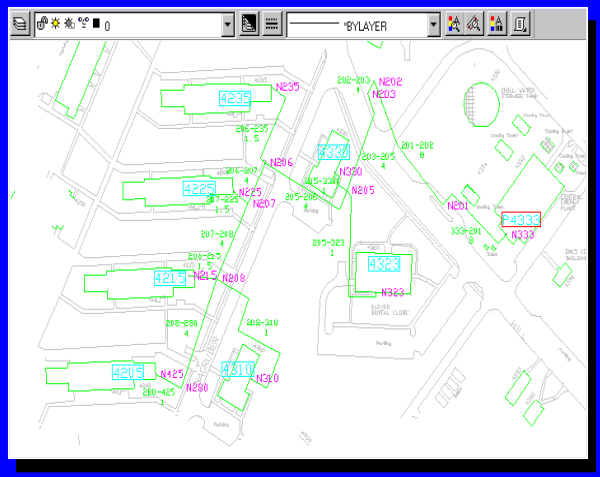
ElectroOsmotic Pulse Technology for Control of Water Seepage in concrete Structures (Ft. Bragg)



- **Problem**: Water seepage into buildings damages structure, corrodes EM equipment and supports biological growth
- **Solution**: ElectroOsmotic pulse technology can dry the structure at 40% lower cost than conventional approach
- **Benefit**:
  - Reduced maintenance and replacement costs of electrical /mechanical equipment due to corrosion
  - Improve indoor air quality by elimination of mold and bacteria
  - Potential $100M DoD savings

Application of Heat Distribution System (HDS) Condition/Corrosion Assessment Procedures (Ft. Jackson)

- **Problem:** Decreasing funds for maintenance and repair of heat distribution piping systems
- **Solution:** Apply previously developed quantitative assessment procedures and prepare to implement computer based HEATER engineering management system
- **Benefit:**
  - Help optimize use of limited maintenance funds
  - Improved planning through scenario based condition prediction ("Condition Prediction Model and Component Interaction Fault Tree for Heat Distribution Systems" ERDC/CERL TR-01-35, July 2001)
  - "apples-to-apples" system wide condition comparisons within SERO



HEATER Engineering Management System

Example of HDS Project

Heat Distribution System (HDS) Manhole High Water Alarms (Ft. Jackson)

- **Problem:** A boiling manhole loses $50-125k/year (TR 98162, June 1998- Marsh, Laughton), and seriously decreases service life
- **Solution**: Provide "negative fault" sensor information for two water levels and one temperature sensors per manhole. Integrate with existing EMCS where applicable.
- Can remotely monitor up to 48 different sensors
- **Benefit:**
  - Avoid excess energy loss
  - Avoid premature failure

Boiling Manhole with Pipe Damage

Boiling Manhole

Possible monitoring system and high water alarm

Assessment for Corrosion Based Sustainability Improvement Opportunities (SIOs) (Ft. Stewart and Ft. Campbell)

- **Problem:** Need to comply with
  - EO 13101 “Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition”
  - ETL 1110-3-491 “Sustainable Design for Military Facilities”
- **Solution:** Identify site specific, materials based, SIOs and assure at least equal performance to what’s replaced
  - Local/regional materials (saves transport)
  - External insulation/finish systems (saves energy)
  - Non-metallic pipe (extended service life)
  - Recycled content in roofing/lumber/trim…
- **Benefits:**
  - Waste reduction/Increased recycled content
  - Extended service life
  - Reduced net energy use/inputs
  - Reduced water use

100% Recycled Content Roofing

“Plastic” lumber- variable conten

Corrosion Control, Materials Durability and Technology Transfer Workshop (all SERO Installations)

- Workshops are held in Champaign-Urbana
- Presentations covered
  - Corrosion basics
  - CP systems
  - Coatings
  - Plastics
- Attendees from SERO DPWs will include both Engineers and support staff

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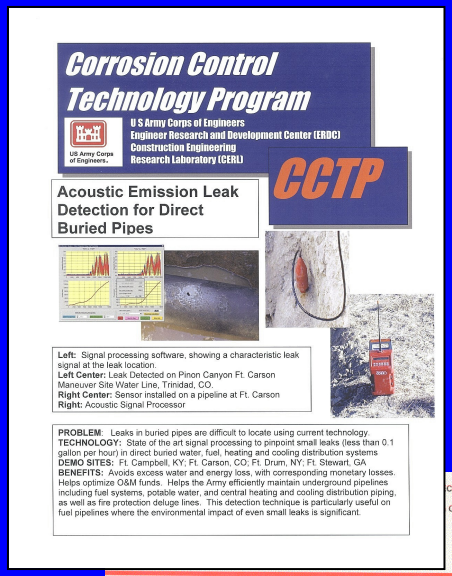
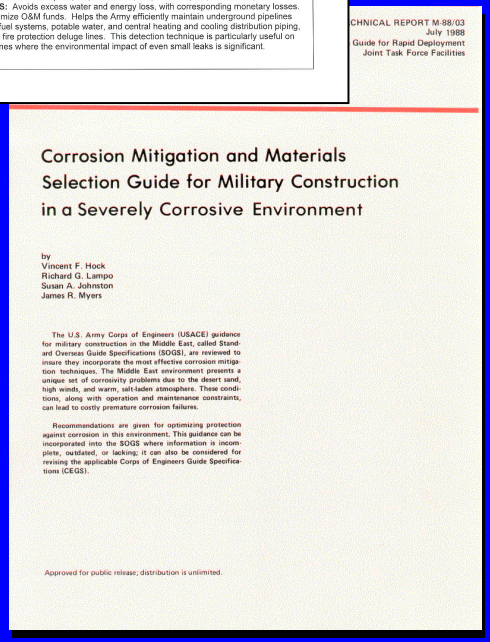
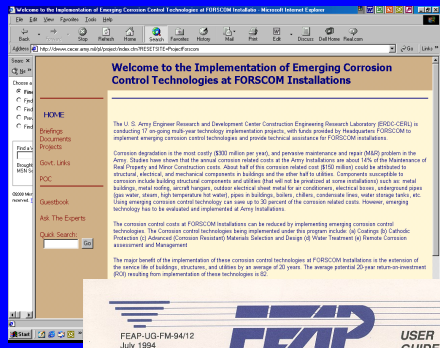
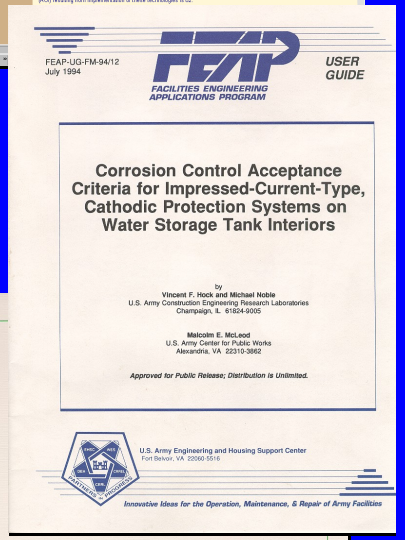
Products

- Implemented Systems on-site
- Boiler Inspections
- User Guides
- Performance specifications
- Training
- Technical Reports
- Ad Fliers


Corrosion Control Technology Program
U S Army Corps of Engineers
Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
CCTP
Acoustic Emission Leak Detection for Direct Buried Pipes
Left: Signal processing software, showing a characteristic leak signal at the leak location.
Left Center: Leak Detected on Pinon Canyon Ft. Carson Maneuver Site Water Line, Trinidad, CO.
Right Center: Sensor installed on a pipeline at Ft. Carson
Right: Acoustic Signal Processor
PROBLEM: Leaks in buried pipes are difficult to locate using current technology.
TECHNOLOGY: State of the art signal processing to pinpoint small leaks (less than 0.1 gallon per hour) in direct buried water, fuel, heating and cooling distribution systems
DEMO SITES: Ft. Campbell, KY; Ft. Carson, CO; Ft. Drum, NY; Ft. Stewart, GA
BENEFITS: Avoids excess water and energy loss, with corresponding monetary losses. Helps optimize O&M funds. Helps the Army efficiently maintain underground pipelines including fuel systems, potable water, and central heating and cooling distribution piping, as well as fire protection deluge lines. This detection technique is particularly useful on fuel pipelines where the environmental impact of even small leaks is significant.


CHNICAL REPORT M-88/03
July 1988
Guide for Rapid Deployment Joint Task Force Facilities
Corrosion Mitigation and Materials Selection Guide for Military Construction in a Severely Corrosive Environment
by
Vincent F. Hock
Richard G. Lampo
Susan A. Johnston
James R. Myers
The U.S. Army Corps of Engineers (USACE) guidance for military construction in the Middle East, called Standard Overseas Guide Specifications (SOGS), are reviewed to insure they incorporate the most effective corrosion mitigation techniques. The Middle East environment presents a unique set of corrosivity problems due to the desert sand, high winds, and warm, salt-laden atmosphere. These conditions, along with operation and maintenance constraints, can lead to costly premature corrosion failures.
Recommendations are given for optimizing protection against corrosion in this environment. This guidance can be incorporated into the SOGS where information is incomplete, outdated, or lacking; it can also be considered for revising the applicable Corps of Engineers Guide Specifications (CEGS).
Approved for public release; distribution is unlimited.




FEAP-UG-FM-94/12
July 1994
FEAP
FACILITIES ENGINEERING APPLICATIONS PROGRAM
USER GUIDE
Corrosion Control Acceptance Criteria for Impressed-Current-Type, Cathodic Protection Systems on Water Storage Tank Interiors
by
Vincent F. Hock and Michael Noble
U.S. Army Construction Engineering Research Laboratories
Champaign, IL 61824-9005
Malcolm E. McLeod
U.S. Army Center for Public Works
Alexandria, VA 22310-3862
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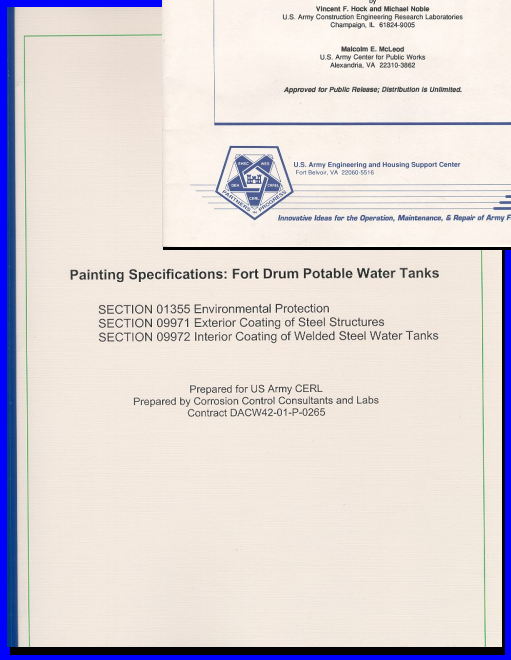
U.S. Army Engineering and Housing Support Center
Fort Belvoir, VA 22060-5516
Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities


Painting Specifications: Fort Drum Potable Water Tanks
SECTION 01355 Environmental Protection
SECTION 09971 Exterior Coating of Steel Structures
SECTION 09972 Interior Coating of Welded Steel Water Tanks
Prepared for US Army CERL
Prepared by Corrosion Control Consultants and Labs
Contract DACW42-01-P-0265